I. PATENT ABSTRACTS OF JAPAN

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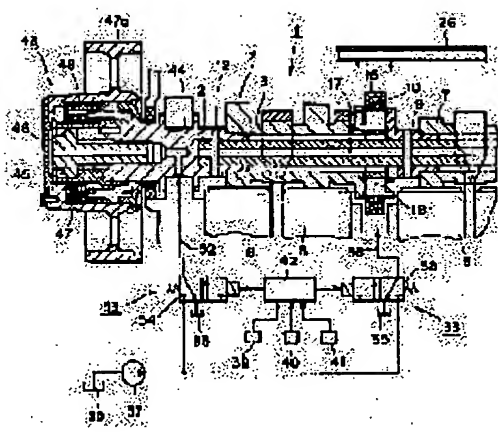
(54) VARIABLE VALVE GEAR FOR INTERNAL COMBUSTION ENGINE



(57)Abstract:
PURPOSE: To increase the fuel consumption at low load and output at high load by properly setting the valve timing of an intake valve according to the operating conditions of an engine.
CONSTITUTION: A variable valve gear comprises a first variable valve gear mechanism 1 formed by connecting a drive shaft 2 to a camshaft 3 through a swingable annular disk 10 and a second variable valve mechanism 43 which generates phase difference between a drive shaft 2 and the crankshaft by the relative rotation of an inner cylinder 45 and an outer cylinder 47. These variable valve gear mechanisms 1 and 43 are controlled through a controller 42. Also the operating angle of an intake valve is changed over successively from large operating angle to small one by the first variable valve gear mechanism l, whereas the operating center angle of the intake valve is adjusted by the second variable valve gear mechanism 43. Then the controller 42 judges the operating conditions of an engine, operates the variable valve gear mechanisms 1 and 43 according to its operating conditions, and set a specified valve timing.

CLAIMS

[Claim(s)]
[Claim 1] The cam shaft which has on a periphery the cam which is arranged on the driving shaft which rotates synchronizing with rotation of an engine, this driving shaft, and the same axle, and drives an induction-exhaust valve, The flange in which it is prepared in the edge of this cam shaft,

and the engagement slot was steadily formed in accordance with radial, The flange of another side in which it was prepared in said driving shaft side so that the flange of one of these might be countered, and the engagement slot was formed in accordance with radial, The annular disk arranged free [rocking] among said both flanges, and the pin which protrudes on an opposite direction mutually at the both-sides section of this annular disk, and engages with each engagement Mizouchi of said both flanges, respectively, An internal combustion engine's good fluctuation valve gear constituted by having the 1st good fluctuation valve system equipped with the drive which makes said annular disk rock according to engine operational status, and the 2nd good fluctuation valve system to which the phase angle of said driving shaft over an engine's crankshaft is changed.

[Claim 2] When an engine is in a low load field, while enlarging the actuation angle of an inlet valve through said 1st good fluctuation valve system When an engine is in a low rotation heavy load field with the 1st control which delays the closing motion stage of an inlet valve through said 2nd good fluctuation valve system, while making the actuation angle of an inlet valve small through said 1st good fluctuation valve system and advancing the open stage of an inlet valve When an engine is in a high rotation heavy load field with the 2nd control which delays the closing motion stage of an inlet valve through said 2nd good fluctuation valve system, while enlarging the actuation angle of an inlet valve through said 1st good fluctuation valve system The good fluctuation valve gear of the internal combustion engine according to claim 1 characterized by having the control means which performs 3rd control to which the closing motion stage of an inlet valve is advanced through said 2nd good fluctuation valve system.

[Claim 3] Said control means is the good fluctuation valve gear of the internal combustion engine according to claim 2 characterized by performing 4th control which makes the actuation angle of an inlet valve the middle magnitude of the actuation angle in a low load field, and the actuation angle in a low rotation heavy load field through said 1st good fluctuation valve system when an engine is in the staging area between said low load field and said low rotation heavy load field.

[Claim 4] Said control means is the good fluctuation valve gear of the internal combustion engine according to claim 2 characterized by performing 5th control which makes the closing motion stage of an inlet valve the middle phase of the closing motion stage in a low load field, and the closing motion stage in a high rotation heavy load field through said 2nd good fluctuation valve system when an engine is in the staging area of said low load field and said high rotation heavy load field.

[Claim 5] Said control means is the good fluctuation valve gear of the internal combustion engine according to claim 2 characterized by constituting so that the actuation angle of an inlet valve may be changed to an abbreviation continuation target through said 1st good fluctuation valve system between the actuation angle in a low load field, and the actuation angle in a low rotation heavy load field when an engine's service condition moves between said low load field and said low rotation heavy load fields.

[Claim 6] Said control means is the good fluctuation valve gear of the internal combustion engine according to claim 2 characterized by constituting so that the closing motion stage of an inlet valve may be changed to an abbreviation continuation target through said 2nd good fluctuation valve system between the closing motion stage in a low load field, and the closing motion stage in a high rotation heavy load field when an engine's service condition moves between said low load field and said high rotation heavy load fields.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention relates to the good fluctuation valve gear which controls the closing motion stage and actuation angle of an inlet valve and an exhaust valve to adjustable according to an internal combustion engine's operational status.
[0002]
[Description of the Prior Art] The good fluctuation valve gear of the internal combustion engine which controls the closing motion stage and actuation angle of an inlet valve and an exhaust valve to adjustable has the thing indicated by JP,5-43847,B as one, although the thing of various formats is offered from the former. The good fluctuation valve gear given [this] in an official report consists of two good fluctuation valve systems of the closing motion operational characteristic modification device which changes alternatively an actuation angle, a high-speed cam with the large amount of lifts and an actuation angle, and a low-speed cam with the small amount of lifts, and the phase adjustment device in which the phase angle of a crankshaft and a cam is changed.
[0003] Although an internal combustion engine has a demand called improvement in the fuel consumption in a low load field, and improvement in the output in a heavy load field here, in order to fill this conflicting requirement, it is known that what is necessary is just to adjust the closing motion stage of an inlet valve as follows.
[0004] First, in a low load field, the open stage of an inlet valve is delayed, the bulb overlap with an exhaust valve is abolished, and fuel consumption can be improved by reducing the amount of the exhaust gas (combustion gas) which remains to a combustion chamber. Moreover, by delaying the closed stage of an inlet valve till the middle of a compression stroke, a pumping loss is reduced and fuel consumption can be improved.
[0005] Next, in a low rotation heavy load field, the open stage of an inlet valve can be advanced, moderate overlap can be secured, and improvement in an output can be aimed at by raising exhaust air effectiveness. Moreover, by advancing the closed stage of an inlet valve, the charging efficiency in low rotation can increase and an output can be improved.
[0006] Furthermore, in a high rotation heavy load field, the open stage of an inlet valve can be advanced, overlap can be enlarged, and improvement in an output can be aimed at by raising exhaust air effectiveness. Moreover, by delaying the closed stage of an inlet valve, the charging efficiency in high rotation can increase and an output can be improved.
[0007] Now, what is necessary is just to change valve timing with the conventional equipment indicated by said official report, according to a service condition, as shown in drawing 14 in order to acquire the closing motion stage property of the optimal inlet valve for each operating range mentioned above.
[0008] That is, when it is in a low load field, while choosing a high-speed cam with a large actuation angle according to a closing motion operational characteristic modification device, it is set as the valve timing I1 shown as a continuous line by delaying the whole closing motion stage by the phase adjuster style. While an open stage is overdue and bulb overlap becomes small by this, a closed stage is overdue and a pumping loss decreases.
[0009] Moreover, when it is in a low rotation heavy load field, while choosing a low-speed cam with a small actuation angle according to a closing motion operational characteristic

modification device, it is set as the valve timing I2 shown with an alternate long and short dash line by advancing the whole closing motion stage by the phase adjuster style. While an open stage is rash and moderate bulb overlap can be acquired by this, a closed stage is rash and a charging efficiency increases.
[0010] Furthermore, what is necessary is just to set it as the valve timing I3 shown by the dotted line by advancing the whole closing motion stage by the phase adjuster style, while choosing a high-speed cam with a large actuation angle according to a closing motion operational characteristic modification device, when it is in a high rotation heavy load field. While an open stage is sharply rash and overlap increases by this, a closed stage is overdue and a charging efficiency improves.
[0011]
[Problem(s) to be Solved by the Invention] However, with the above-mentioned conventional equipment, by using a closing motion operational characteristic modification device and a phase adjuster style, it is difficult to deal with fluctuation of an actual service condition of what can change the valve timing of an inlet valve suitably according to a service condition promptly, and there is a possibility of causing the fall of operability etc.
[0012] That is, as usual operational status, when an accelerator is broken in, for example from a steady operation condition, a service condition shifts to a high rotation heavy load field in many cases from the low rotation heavy load field from a low load field, or a low load field.
[0013] Here, as shown in drawing 14 , when shifting to a high rotation heavy load field from a low load field, it can change from the valve timing I1 at the time of a low load to the valve timing I3 at the time of a high rotation heavy load by operating only a phase adjuster style and advancing the closing motion stage of an inlet valve.
[0014] However, if a closing motion stage is not advanced by the phase adjuster style while making an actuation angle small according to a closing motion operational characteristic modification device when a service condition shifts to a low rotation heavy load field from a low load field, it cannot change from the valve timing I1 at the time of a low load to the valve timing I2 at the time of a low rotation heavy load.
[0015] Namely, in this case, since actuation of both devices is needed, operate a phase adjuster style first and valve timing is moved to I3. [whether a closing motion operational characteristic modification device is operated after that, and valve timing I2 is reached and] Or it must carry out whether contrary to this, a closing motion operational characteristic modification device is operated first, it moves into drawing 14 at the middle valve timing I4 shown with a two-dot chain line, a phase adjuster style is operated after that, and valve timing I2 is reached.
[0016] Therefore, in the process in which two steps of these adjustments are performed, the valve timing of an inlet valve may shift from desirable timing inevitably, and performance may get worse in the meantime.
[0017] Moreover, even if it is going to operate both devices to coincidence, it is difficult to make the actuation rate of both devices in agreement as a matter of fact. Furthermore, even if coincidence actuation is realized, in order to have to supply predetermined actuation oil pressure to both devices at coincidence, respectively, the need of enlarging capacity of an oil pump is produced and cost increase etc. is invited.
[0018]
[Means for Solving the Problem] Then, by using the 1st good fluctuation valve system which gives rotation phase contrast between a driving shaft and a cam shaft, and the 2nd good fluctuation valve system to which the phase angle of the driving shaft over a crankshaft is

changed, this invention realized easily valve timing according to an engine's operational status, and presupposed it that improvement in operability etc. is aimed at. Namely, the good fluctuation valve gear of the internal combustion engine concerning this invention The cam shaft which has on a periphery the cam which is arranged on the driving shaft which rotates synchronizing with rotation of an engine, this driving shaft, and the same axle, and drives an induction-exhaust valve, The flange in which it is prepared in the edge of this cam shaft, and the engagement slot was steadily formed in accordance with radial, The flange of another side in which it was prepared in said driving shaft side so that the flange of one of these might be countered, and the engagement slot was formed in accordance with radial, The annular disk arranged free [rocking] among said both flanges, and the pin which protrudes on an opposite direction mutually at the both-sides section of this annular disk, and engages with each engagement Mizouchi of said both flanges, respectively, It has the 1st good fluctuation valve system equipped with the drive which makes said annular disk rock according to engine operational status, and the 2nd good fluctuation valve system to which the phase angle of said driving shaft over an engine's crankshaft is changed, and is constituted.

[0019] Moreover, when an engine is in a low load field, while enlarging the actuation angle of an inlet valve through said 1st good fluctuation valve system in the configuration of claim 1 with the configuration of claim 2 When an engine is in a low rotation heavy load field with the 1st control which delays the closing motion stage of an inlet valve through said 2nd good fluctuation valve system, while making the actuation angle of an inlet valve small through said 1st good fluctuation valve system and advancing the open stage of an inlet valve When an engine is in a high rotation heavy load field with the 2nd control which delays the closing motion stage of an inlet valve through said 2nd good fluctuation valve system, while enlarging the actuation angle of an inlet valve through said 1st good fluctuation valve system It is characterized by having the control means which performs 3rd control to which the closing motion stage of an inlet valve is advanced through said 2nd good fluctuation valve system.

[0020] furthermore -- the configuration of claim 3 -- the configuration of claim 2 -- in addition, said control means is characterized by to perform 4th control which makes the actuation angle of an inlet valve the middle magnitude of the actuation angle in a low load field, and the actuation angle in a low rotation heavy load field through said 1st good fluctuation valve system, when an engine is in the staging area between said low load field and said low rotation heavy load field.

[0021] moreover -- the configuration of claim 4 -- the configuration of claim 2 -- in addition, said control means is characterized by performing 5th control which makes the closing motion stage of an inlet valve the middle phase of the closing motion stage in a low load field, and the closing motion stage in a high rotation heavy load field through said 2nd good fluctuation valve system, when an engine is in the staging area of said low load field and said high rotation heavy load field.

[0022] With the configuration of claim 5, it sets in the configuration of claim 2. Furthermore, said control means In case an engine's service condition moves between said low load field and said low rotation heavy load fields, it is characterized by constituting so that the actuation angle of an inlet valve may be changed to an abbreviation continuation target through said 1st good fluctuation valve system between the actuation angle in a low load field, and the actuation angle in a low rotation heavy load field.

[0023] Moreover, with the configuration of claim 6, in the configuration of claim 2, said control means is characterized by constituting so that the closing motion stage of an inlet valve may be changed to an abbreviation continuation target through said 2nd good fluctuation valve system

between the closing motion stage in a low load field, and the closing motion stage in a high rotation heavy load field, in case an engine's service condition moves between said low load field and said high rotation heavy load fields.
[0024]
[Function] In order to be uniform velocity, namely, to rotate without phase contrast synchronizing with a driving shaft, in the control state according to which the core of the annular disk of the 1st good fluctuation valve system has agreed with the core of a driving shaft, an induction-exhaust valve opens a cam shaft and closes along with the profile of a cam. On the other hand, in order that the core of an annular disk may carry out eccentricity from the core of a driving shaft, as a result of a driving shaft and a cam shaft coming to interlock at non-uniform velocity and producing phase contrast during rotation, an induction-exhaust valve opens [after the annular disk has rocked to one side with the drive] and closes that it is also at a property which the profile of a cam was made to **** according to phase contrast. On the other hand, the 2nd good fluctuation valve system can change the phase angle of the driving shaft over an engine's crankshaft.
[0025] Therefore, an actuation angle and a closing motion stage can be adjusted suitably, and the good fluctuation valve system of these 1st and the 2nd good fluctuation valve system enable it to realize various valve timing according to an engine's operational status. In addition, in case it changes into other valve timing from the valve timing of 1 by changing continuously the eccentricity of said annular disk and driving shaft, and the phase angle variation of said crankshaft and driving shaft, it also becomes possible to change this timing continuously.
[0026] Moreover, a closed stage is delayable, making overlap small by 1st control which delays a closing motion stage according to the configuration of claim 2, while enlarging the actuation angle of an inlet valve. A closed stage can be brought forward rather than the 1st control, forming moderate overlap by 2nd control which delays a closing motion stage, while making an actuation angle small, setting forward the open stage of an inlet valve. A closed stage is comparatively delayable, forming big overlap by 3rd control to which a closing motion stage is advanced, while enlarging the actuation angle of an inlet valve. Moreover, when an engine shifts between a low load field and low rotation heavy load fields, the valve timing suitable for each field can be obtained by operating only the 1st good fluctuation valve system which can adjust the both sides of an actuation angle and a closing motion stage to coincidence.
[0027] Furthermore, since according to the configuration of claim 3 the actuation angle of an inlet valve passes through a middle value in case an engine shifts between a low load field and low rotation heavy load fields, the torque shock at the time of shift can be reduced.
[0028] Moreover, since according to the configuration of claim 4 the closing motion stage of an inlet valve passes through a middle phase in case an engine shifts between a low load field and high rotation heavy load fields, the torque shock at the time of shift can be reduced.
[0029] Furthermore, since according to the configuration of claim 5 the actuation angle of an inlet valve is changed to an abbreviation continuation target in case an engine shifts between a low load field and low rotation heavy load fields, the torque shock at the time of shift can be reduced.
[0030] Moreover, since according to the configuration of claim 6 the closing motion stage of an inlet valve is changed to an abbreviation continuation target in case an engine shifts between a low load field and high rotation heavy load fields, the torque shock at the time of shift can be reduced.
[0031]

[Example] Hereafter, the example of the good fluctuation valve gear of the internal combustion engine concerning this invention is explained based on drawing 1 - drawing 13 .
[0032] First, drawing 1 is the configuration explanatory view showing the 1st whole example configuration, this good fluctuation valve gear is constituted considering the 1st good fluctuation valve system 1 and the 2nd good fluctuation valve system 43 which are mentioned later as a subject, and the actuation oil pressure supplied to each [these] good fluctuation valve systems 1 and 43 is controlled by the controller 42.
[0033] If it explains referring to the expanded sectional view of drawing 2 R> 2 about introduction and the 1st good fluctuation valve system 1, turning effort is transmitted to the hollow-like driving shaft 2 installed in an engine's cross direction through a sprocket (neither is illustrated) from a crankshaft, and the cam shaft 3 divided into the periphery for every gas column is arranged in Core X and the same axle of a driving shaft 2 through the fixed clearance.
[0034] Moreover, while the cam shaft 3 is supported by the cam shaft carrier of the cylinder head upper limit section which is not illustrated free [rotation], as shown in drawing 3 and drawing 4 , two or more cam 7 -- which the spring force of a valve spring 5 is resisted [--] and carries out open actuation of the inlet valve 4 by the valve lifter 6 is prepared in the predetermined location of a periphery at one.
[0035] Furthermore, although division formation of the cam shaft 3 is carried out at plurality as mentioned above, the flange 8 is formed in the division edge of one of these. Moreover, the sleeve 9 and the annular disk 10 are arranged between the edges of the cam shaft 3 divided into this plurality, respectively. Said flange 8 has flange-face 8a which ****s on one front face of the annular disk 10 while the engagement slot 11 of the shape of a long and slender rectangle which met radial from the centrum is formed, as shown also in drawing 5 .
[0036] Connection immobilization of said sleeve 9 is carried out at this driving shaft 2 through the connection pin 12 by which the minor diameter end section is inserted in the division edge circles of another side of a cam shaft 3 free [rotation] and which had fitted into the periphery of a driving shaft 2, and was both penetrated in the diameter direction. Moreover, as the flange 13 prepared in the other end of a sleeve 9 counters with the flange 8 by the side of a cam shaft 3, and is located and is shown also in drawing 6 , while the engagement slot 14 of the shape of a long and slender rectangle in alignment with radial is formed, it has flange-face 9a which ****s to a peripheral face on the front face of another side of the annular disk 10. Said engagement slot 14 is arranged in the opposite side different 180 degrees from the engagement slot 11 of the cam-shaft 3 side flange 8.
[0037] While said annular disk 10 presents abbreviation doughnut tabular, a bore is formed in the bore and ****** of a cam shaft 3 and the annular clearance section S is formed between the peripheral faces of a driving shaft 2, narrow periphery section 10a is held free [rotation] through the annular bearing metal 15 at the inner skin of the control ring 16. Moreover, respectively the maintenance holes 10b and 10c penetrate in the opposite location on a diameter line which is mutually different 180 degrees, it is formed in it, and fitting arrangement of the pins 17 and 18 of the pair which engages with each engagement slots 11 and 14 is carried out at these each maintenance holes 10b and 10c.
[0038] While having projected each [these] pins 17 and 18 of each other to the reverse sense to the shaft orientations of a cam shaft 3 and enabling fitting support of the rotation of the base which consists of a cylinder side in maintenance hole 10b and 10c As shown in drawing 5 and drawing 6 , the flat-surface sections 17a, 17b, 18a, and 18b of the shape of 2 plane widths which contacts the opposite insides 11a, 11b, 14a, and 14b of each engagement slots 11 and 14 are

formed in the point which projects from the front face of the annular disk 10, respectively.
[0039] Moreover, positioning to the shaft orientations of each pins 17 and 18 About the protrusion direction, by the contact to Steps 17c and 18c and the flange faces 8a and 9a which are produced between the cylinder side of pins 17 and 18, and said flat-surface sections 17a, 17b, 18a, and 18b Moreover, about the retreat direction, it is carried out by the contact to the end face sides 17d and 18d of pins 17 and 18 and flange faces 9a and 9a which penetrated said maintenance holes 10b and 10c, respectively.
[0040] As shown in drawing 3 , said control ring 16 has boss section 16a on a part of periphery, and is constituted free [rocking] up and down along the field which intersects perpendicularly with the shaft orientations of a driving shaft 2 by using as the supporting point the rocking shaft 19 which penetrated this boss section 16a, while making approximate circle annular. Moreover, lever section 16b protrudes on the peripheral face of boss section 16a and the opposite side in accordance with radial, and when the below-mentioned drive 28 operates this lever section 16b, the rocking location of the control ring 16 is controlled.
[0041] Moreover, as shown in drawing 3 and drawing 7 , the lubricating oil path 20 where a lubricating oil is fed is established in said rocking shaft 19 interior from an engine's oil gallery, and the lubrication of the sliding surface of a bearing metal 15 and the annular disk 10 is carried out through the oil supply holes 21, 22, and 23 from here. Said oil supply hole 22 and the oil groove 24 open for free passage are formed in the peripheral face of the annular disk 10, and a lubricating oil spreads round the perimeter of the annular disk 10. Moreover, from this oil groove 24, as shown in drawing 2 , the oil supply hole 25 is formed towards the maintenance holes 10b and 10c of each pins 17 and 18. Forced lubrication between the annular disk 10 and the control rings 16 and of between the annular disk 10 and pins 17 and 18 is carried out by these lubrication devices.
[0042] Moreover, as shown in drawing 2 , in accordance with those shaft orientations, the oil supply pipe 26 is arranged above the driving shaft 2 and the cam shaft 3, and opening formation of the oil supply hole 27 is carried out towards near the boundary of each flanges 8 and 13 and the annular disk 10 at this oil supply pipe 26, respectively. The lubrication of between each pins 17 and 18 and the engagement slots 11 and 14 is carried out to this oil supply pipe 26 to the lubricating oil which an engine lubricating oil is fed too and supplied from the oil supply hole 27.
[0043] the 1st which countered the predetermined part of the cylinder head mutually and was formed in it as the drive 28 which makes the control ring 16 rock was shown in drawing 3 -- with 29 and 30 the 2nd cylinder As it is indicated in drawing 1 as the oil pressure piston 31 and retainer 32 which fitted in free [frequent appearance] in each cylinder 29 and 30, it has the hydraulic circuit 33 which the feeding and discarding of the oil pressure are carried out [hydraulic circuit] to oil pressure room 29a formed in said 1st cylinder 29, and makes the oil pressure piston 31 move. Said oil pressure piston 31 and retainer 32 counter mutually, and pinch the circular point of said lever section 16b from the upper and lower sides between both tips.
[0044] Here, the retainer 32 prepared in said 2nd cylinder 30 is formed in the shape of an abbreviation closed-end cylinder, and is energized in the protrusion direction by the spring force of the coil spring 34 arranged in 2nd cylinder 30. Moreover, in the maximum retreat location which the retreat location was regulated and contacted this base, when the 1st cylinder contacts the base of 29, said oil pressure piston 31 is set up so that the center of rotation Y of the annular disk 10 and the core X of a driving shaft 2 may serve as concentric voice.
[0045] Said hydraulic circuit 33 mainly consists of solenoid valves 38 of the 3 port 2 location mold with which the end section was prepared in an engine's oil pan mechanism 35 at the

downstream of the oil path 36 which the other end opened for free passage to oil pressure room 29a, respectively, the oil pump 37 prepared in the oil-pan-mechanism 35 side of this oil path 36, and this oil pump 37. In addition, generally this hydraulic circuit 33 is constituted using engine lubricating system, and becomes what shared the oil-pump 37 grade with engine lubricating system.

[0046] Moreover, the crank angle sensor by which 39 detects an engine's crank angle, the air flow meter with which 40 detects an inhalation air content, and 41 show the coolant temperature sensor which detects an engine's cooling water temperature, respectively, and each [these] sensors 39, 40, and 41 are connected to the controller 42.

[0047] The controller 42 as a control means which carries out centralized control of the engine is constituted as a microcomputer system, like the after-mentioned, it distinguishes an engine's operational status based on the detecting signal from each sensors 39, 40, and 41, outputs a control signal to said solenoid valve 38 and other solenoid valves 54 mentioned later according to this operational status, and switches these.

[0048] Here, in case this controller 42 switches each solenoid valves 38 and 54, it performs duty control by that midcourse phase. That is, in switching to an OFF signal, for example from ON signal, it lowers the ratio of ON time amount gradually in a predetermined short time from the condition of 100% of outputs, and contrary to this, in switching to ON signal from an OFF signal, it gathers the ratio of ON time amount from the condition of 0% of outputs gradually into a predetermined short time. Thereby, the pressure of the hydraulic oil supplied through each solenoid valves 38 and 54 changes to an abbreviation continuation target stair-like.

[0049] Next, based on drawing 8 , the 2nd good fluctuation valve system 43 is explained.

[0050] First, drawing 8 is the sectional view expanding and showing the detail of the 2nd good fluctuation valve system 43, and this 1st good fluctuation valve system 43 consists of the below-mentioned sleeve 44, a container liner 45, an outer case 47, and piston 48 grade.

[0051] That is, a sleeve 44 is inserted in the front end of a cam shaft 3 rotatable, and is being fixed to the driving shaft 2 through the connection pin 12. the cup-like outer case 47 with which the container liner 45 fixed through the mounting bolt 46 in the front end of this sleeve 44, and cam pulley 47a was formed in the periphery side of this container liner 45 in one -- about 10 [for example,] -- about [degree] relativity -- fitting is carried out pivotable.

[0052] Moreover, the ring-like piston 48 was formed between the container liner 45 and the outer case 47, and this piston 48 has geared through a helical spiral rib, respectively to the peripheral face of a container liner 45, and the peripheral face of an outer case 47.

[0053] Furthermore, the piston 48 is always energized towards the front with the return spring 49, and the oil pressure room 50 is formed between the front face of a piston 48, and the covering device rear face of an outer case 47 that this spring force should be opposed. And this oil pressure room 50 is connected to the solenoid valve 54 in the hydraulic circuit 53 for the 2nd good fluctuation valve-system 43 as shown in drawing 1 R> 1 through the oil path 51 in a mounting bolt 46, and the oil path 52 formed in the sleeve 44. And this hydraulic circuit 53 supplies actuation oil pressure to the 2nd good fluctuation valve system 43 according to the control signal of a controller 42.

[0054] Next, it explains, referring to drawing 9 about an operation of the 1st good fluctuation valve system 1.

[0055] First, if an OFF signal is outputted to a solenoid valve 38 from a controller 42, the oil path 36 and an oil pan mechanism 35 will be connected through this solenoid valve 38. For this reason, the oil pressure in oil pressure room 29a is released, and it retreats to the maximum

retreat location where the 1st cylinder of the oil pressure piston 31 contacts the base of 29 by the spring force of a valve spring 5 and a coil spring 34.
[0056] Therefore, the center of rotation Y of the control ring 16 10, i.e., an annular disk, and the core X of a driving shaft 2 agree. That is, it will be in the condition that a continuous line shows in drawing 3 . In this case, since rotation phase contrast does not arise between the annular disk 10 and a driving shaft 2 and the core of a cam shaft 3 and the core Y of the annular disk 10 agree, both 3 and the rotation phase contrast between ten are not produced, either.
[0057] Therefore, three persons of a driving shaft 2, the annular disk 10, and a cam shaft 3 do synchronous rotation at uniform velocity through pins 17 and 18. Consequently, the valve-lift property in alignment with a cam profile as shown in the continuous line in drawing 9 (A) is acquired. Moreover, at this time, slipping does not arise substantially between pins 17 and 18 and the engagement slots 11 and 14.
[0058] On the other hand, if ON signal is outputted to a solenoid valve 38 from a controller 42, a solenoid valve 38 will switch, the hydraulic oil from an oil pump 37 will be supplied to oil pressure room 29a through the oil path 36, and the internal pressure of oil pressure room 29a will rise.
[0059] As the oil pressure piston 31 shows with the alternate long and short dash line in drawing 3 , in order to resist the spring force of a coil spring 34 and to push up lever section 16b to a predetermined location in connection with this pressure buildup, the control ring 16 rocks upwards by using the rocking shaft 19 as the supporting point, and as the core Y of the annular disk 10 shows as Y' in drawing 3 , eccentricity is carried out from the core X of a driving shaft 2.
[0060] In this condition, each of sliding locations of the engagement slot 14 of a sleeve 9 and a pin 18 and sliding locations of the engagement slot 11 of a cam shaft 3 and a pin 17 moves for every rotation of a driving shaft 2, and becomes the non-uniform rotation from which the angular velocity of the annular disk 10 changes.
[0061] Especially, in one stop slot 14 and the include-angle field in which the sliding location of a pin 18 approaches the core X of a driving shaft 2, the sliding location of the stop slot 11 on another side and a pin 17 becomes the relation which separates from Core X. In this case, to a driving shaft 2, angular velocity becomes small and, as for the annular disk 10, the angular velocity of a cam shaft 3 also becomes small to the annular disk 10 further. Therefore, in the angular velocity of a cam shaft 3, a duplex will slow down to a driving shaft 2.
[0062] On the contrary, in one stop slot 14 and the include-angle field which the sliding location of a pin 18 estranges from the core X of a driving shaft 2, the sliding location of the stop slot 11 on another side and a pin 17 becomes the relation close to Core X. In this case, to a driving shaft 2, angular velocity becomes large and, as for the annular disk 10, the angular velocity of a cam shaft 3 also becomes large to the annular disk 10 further. Therefore, a duplex will accelerate [the angular velocity of a cam shaft 3] to a driving shaft 2.
[0063] Thereby, as an alternate long and short dash line shows in drawing 9 (B), comparatively big phase contrast is given between a driving shaft 2 and a cam shaft 3. Moreover, a point (P points) in phase exists in the middle of the max of rotation phase contrast, and a minimum point. In addition, in the property Fig. of drawing 9 (B), the cam shaft 3 has made negative phase contrast of the direction which is just relatively overdue in the phase contrast of the direction which progresses relatively.
[0064] And the valve-opening stage of the inlet valve 4 located in the field to which a cam shaft 3 becomes a delay side relatively will be overdue in connection with said phase contrast. On the contrary, the clausilium stage of the inlet valve 4 located in the field to which a cam shaft 3

serves as the advancing side relatively will progress in connection with phase contrast. Therefore, a valve-lift property as shown with an alternate long and short dash line in drawing 9 (A) is acquired, and the actuation angle becomes small.

[0065] Here, as shown in drawing 9 , the lift start point Q1 at the time of the same axle mentioned above is set up so that it may become immediately after the point P in phase. Thereby, in the lift start point Q2 at the time of eccentricity, while only the rotation phase contrast delta 1 becomes early, as for the lift terminal point R2 at the time of eccentricity, only the rotation phase contrast delta 2 consists of a lift start point Q1 at the time of the same axle early rather than the lift terminal point R1 at the time of the same axle.

[0066] Next, an operation of the 2nd good fluctuation valve system 43 is explained.

[0067] First, if a controller 42 outputs an OFF signal to other solenoid valves 54, the oil pressure room 50 and an oil pan mechanism 35 will be connected. In order that the pressure in the oil pressure room 50 may be released and a piston 48 may not move to shaft orientations by this, a container liner 45 and an outer case 47 do not carry out relative rotation, but the phase angle of a driving shaft 2 and its phase angle of a crankshaft correspond. Here, when phase contrast does not arise between a driving shaft 2 and a crankshaft, it is set up so that the closing motion stage of an inlet valve 4 may be overdue as a whole.

[0068] On the other hand, if ON signal is outputted to a solenoid valve 54 from a controller 42, this solenoid valve 54 will switch and the hydraulic oil from an oil pump 37 will be supplied in the oil pressure room 50 through oil path 52 grade. Thereby, a piston 48 moves to shaft orientations and movement of these shaft orientations is changed into relative rotation with a container liner 45 and an outer case 47. for this reason, a difference arises in the phase angle of a driving shaft 2 and a crankshaft, and it is shown in the continuous-line wave and dotted-line wave in drawing 11 -- as -- actuation of an inlet valve 4 -- a central angle -- the very thing moves, and both an open stage and a closed stage are rash, or it becomes late.

[0069] Next, it explains to a detail, referring to drawing 1010 and drawing 11 about an operation of the whole good fluctuation valve gear.

[0070] First, a controller 42 has a change-over map of operation as shown in drawing 10 , and the valve timing of an inlet valve 4 is controlled based on this map. This change-over map of operation is divided into three fields, the low load field A, the low rotation heavy load field B, and the high rotation heavy load field C.

[0071] And a controller 42 detects an engine's rotational frequency and torque based on the detecting signal of each sensors 39, 40, and 41, after it judges whether an engine's operational status is in which field among each fields A, B, and C, outputs a control signal to each solenoid valves 38 and 54 according to each fields A, B, and C, and operates each good fluctuation valve systems 1 and 43.

[0072] First, when an engine is in the low load field A, a controller 42 outputs an OFF signal to a solenoid valve 38, makes in agreement the core Y of the annular disk 10, and the core X of a driving shaft 2, makes rotation phase contrast zero, and sets the actuation angle of an inlet valve 4 as the large actuation angle alpha at the time of the same axle. on the other hand -- a controller 42 -- other solenoid valves 54 -- an OFF signal -- outputting -- the phase contrast between a driving shaft 2 and a crankshaft -- not being generated -- making -- actuation -- a central angle is set to a delay side, and this obtains the valve timing a at the time of a low load, as shown in the continuous-line wave in drawing 1111 . Both the open stages and closed stages of an inlet valve 4 are large, and delay and overlap are small, or it stops therefore, occurring.

[0073] Next, when an engine's load goes up and it goes into the low rotation heavy load field B,

a controller 42 outputs ON signal only to a solenoid valve 38, makes the control ring 16 rock holding the 2nd good fluctuation valve system 43 in the case of the low load field A, carries out eccentricity of the annular disk 10 to a driving shaft 2, and switches the actuation angle of an inlet valve 4 to the small actuation angle beta at the time of eccentricity. Both an open stage and a closed stage are rash by this, the actuation angle of an inlet valve 4 narrowing, and as shown in the alternate long and short dash line wave in drawing 11 , the valve timing b at the time of a low rotation heavy load is obtained. Therefore, a closed stage is greatly rash while overlap arises moderately. Here, since duty control is performed as mentioned above in case an actuation angle is switched to the small actuation angle beta from the large actuation angle alpha by the 1st good fluctuation valve system 1, the actuation angle of an inlet valve 4 is switched to a parenchyma-like continuation target.

[0074] furthermore, when an engine goes into the high rotation heavy load field C, a controller 42 outputs ON signal to other solenoid valves 54, and generates phase contrast between a driving shaft 2 and a crankshaft -- making -- actuation of an inlet valve 4 -- a central angle is brought forward. On the other hand, a controller 42 outputs an OFF signal to the solenoid valve 38 of the 1st good fluctuation valve system 1, returns the relation between the annular disk 10 and a driving shaft 2 to the same axle, and switches an actuation angle to the large actuation angle alpha. Thereby, while an open stage is greatly rash, a closed stage comes to be located in the abbreviation middle with the time of a low load and a low rotation heavy load, and as shown in the dotted-line wave in drawing 11 , the valve timing c at the time of a high rotation heavy load is obtained. here -- above -- an actuation angle and actuation -- since duty control is performed in case a central angle is switched -- these actuation angle and actuation -- the central angle changes continuously smoothly [in macro] stair-like in micro.

[0075] If the above result is summarized, it will become as it is shown in the following table 1.

[0076]

[Table 1]

[0077] Thus, the 1st good fluctuation valve system 1 which comes to connect a driving shaft 2 and a cam shaft 3 by the rockable annular disk 10 according to this example, Since the good fluctuation valve gear was constituted from the 2nd good fluctuation valve system 43 to which the phase angle of a driving shaft 2 and a crankshaft is changed by relative rotation with a container liner 45 and an outer case 47, the actuation angle and closing motion stage of an inlet valve 4 are changed with the 1st good fluctuation valve systems 1 by controlling the hydraulic oil supplied to each good fluctuation valve systems 1 and 43 -- it can make -- the 2nd good

fluctuation valve system 43 -- actuation of an inlet valve 4 -- a central angle can be changed. Consequently, the various valve timing according to an engine's operational status can be obtained easily.

[0078] Moreover, as shown in said Table 1 and drawing 11 , according to an engine's operational status, each good fluctuation valve systems 1 and 43 are operated, and it writes as the configuration which obtains the valve timing a at the time of a low load, the valve timing b at the time of a low rotation heavy load, and the valve timing c at the time of a high rotation heavy load, and in the time of a low load, fuel consumption can be improved and an output can be increased at the time of a heavy load.

[0079] That is, in the low load field A, in order that the closed stage of an inlet valve 4 may be greatly overdue till the middle of a top dead center (TDC) and a bottom dead point (BDC), the gaseous mixture once inhaled by the combustion chamber is returned within inhalation of air again, the amount of inhalation falls, a pumping loss decreases sharply, and fuel consumption improves. On the other hand, the open stage of an inlet valve 4 becomes late, since bulb overlap is small or does not arise, the residual gas of a combustion chamber can be lessened, a combustion condition can be stabilized, and, thereby, fuel consumption improves.

[0080] Moreover, in the low rotation heavy load field B, the open stage of an inlet valve 4 is rash from the time of a low load, moderate overlap arises, exhaust air effectiveness increases, and an output increases. since the closed stage of an inlet valve 4 is sharply rash on the other hand -- the gaseous mixture in low rotation -- a charging efficiency increases and an output increases also by this.

[0081] Furthermore, in the high rotation heavy load field C, since the open stage of an inlet valve 4 is sharply rash and bulb overlap increases while the charging efficiency at the time of high rotation increases, since the closed stage of an inlet valve 4 becomes comparatively late, exhaust air effectiveness also increases. Therefore, an output improves in this case.

[0082] On the other hand, in this example, the valve timing a at the time of low rotation and the valve timing b at the time of a low rotation heavy load can be promptly switched by operating only this 1st good fluctuation valve system 1 for the configuration which uses the 1st good fluctuation valve system 1 which can adjust the both sides of an actuation angle and a closing motion stage by adjustment of the physical relationship of the rocking direction of the annular disk 10, and a cam 7 etc.

[0083] That is, by actuation of the single good fluctuation valve system 1, since it is set up so that the lift start point Q2 may become earlier than the lift start point Q1 at the time of the same axle (at the time of the large actuation angle alpha) when an actuation angle turns into the small actuation angle beta by the 1st good fluctuation valve system 1 as shown in drawing 9 (A), while bringing forward the closed stage of an inlet valve 4 greatly, an open stage can also be comparatively brought forward.

[0084] Therefore, it is not necessary to be stabilized, to switch valve timing a and b promptly, and to enlarge capacity of an oil pump 37 excessively, and fuel consumption improves further between the low load fields A and the low rotation heavy load fields B which switch frequently in actual operational status. On the other hand, according to the equipment given in an official report stated with the conventional technique, although it is selectable, only an actuation angle and the amount of lifts can adjust two kinds such as a high-speed cam and a low-speed cam, but since adjustment of a closing motion stage is essentially impossible, the shift between the low load field A and the low rotation heavy load field B cannot be performed only by change-over of a cam, but phase angle adjustment of a crankshaft and a driving shaft 2 is also needed. However,

in this example, since what is necessary is just to operate only the 1st good fluctuation valve system 1, the configuration is simple and stable valve timing control can be performed.
[0085] in addition, when shifting between the low load field A and the high rotation heavy load fields C, it is shown in Table 1 -- as -- the 2nd good fluctuation valve system 43 -- actuation of an inlet valve 4 -- since it is sufficient if only a central angle is adjusted, it is stabilized and the same effectiveness as the above, i.e., predetermined valve timing, can be acquired certainly.
[0086] moreover, the time of switching each good fluctuation valve systems 1 and 43 in this example -- duty control -- carrying out -- abbreviation -- it can write as the configuration to which the pressure of hydraulic oil is changed smoothly, the torque shock at the time of switching valve timing can be reduced sharply, and operability can be improved.
[0087] Next, the 2nd example of this invention is explained based on drawing 12. In addition, in this example, the same sign shall be given to the same component as the 1st example mentioned above, and the explanation shall be omitted.
[0088] That is, drawing 12 is a change-over map of operation by this example, the 1st staging area D is arranged between the low load field A and the low rotation heavy load field B, and the 2nd staging area E is arranged between the low load field A and the high rotation heavy load field C.
[0089] In this 1st staging area D, and ON time amount ratio of the duty control at the time of the shift to the solenoid valve 38 of the 1st good fluctuation valve system 1 Mean value M1% which is the any value between 0 - 100% (however, 100% of an upper limit is removed 0% of a minimum, for example, it is about 20 - 80% of range) The middle actuation angle gamma between the large actuation angle alpha at the time of a low load and the small actuation angle beta at the time of a low rotation heavy load (not shown) is generated, and between both the fields A and B is made to shift gradually by supposing that it is preferably set up in about 40 - 60% of range.
[0090] On the other hand by said 2nd staging area E, ON time amount ratio of the duty control at the time of the shift to the solenoid valve 54 of the 2nd good fluctuation valve system 43 M2% of the mean value (however, in about 20 - 80% of range like said M1) which is the any value between 0 - 100% supposing that it is preferably set up in about 40 - 60% of range -- the late actuation at the time of a low load -- the quick actuation at the time of a central angle and a high rotation heavy load -- the middle actuation between central angles -- a central angle is generated and between both the fields A and C is made to shift gradually
[0091] Thus, the effectiveness as the 1st example mentioned above that this example constituted is also almost the same can be acquired. In addition, by this example, there is no upper fault, and although the smoothness at the time of shift is a little missing strictly for the configuration which performs duty control by the three-stage in case valve timing is switched, control can actually be simplified especially further on the contrary, maintaining fundamental effectiveness.
[0092] Next, drawing 13 shows the 3rd example of this invention. In addition, in this example, the same sign shall be given to the same component as the component stated in said 1st example, and the explanation shall be omitted.
[0093] That is, this example changes 180 degrees of phases of the pins 17 and 18 to the profile of a cam 7 compared with the 1st example, and thereby, when the annular disk 10 is in an eccentric condition to a driving shaft 2, it is constituted so that an actuation angle may spread. In addition, an actuation angle comes to spread similarly considering the eccentric direction as hard flow, without changing the phase relation between a cam 7 and pins 17 and 18. And in this example, the lift start point Q1 at the time of the same axle (at the time of the small actuation angle beta) is

set up immediately after the point P in phase in case the phase contrast of the cam shaft 3 to a driving shaft 2 changes to negative from forward.
[0094] Thus, the almost same effectiveness as the 1st example which also mentioned this example constituted above can be acquired.
[0095] In addition, although the case where it applied only to the drive of an inlet valve 4 was illustrated in said each example, this invention is applicable not only to this but an exhaust valve.
[0096] Moreover, although by carrying out duty control of the electrical potential difference impressed to each solenoid valves 38 and 54 described actuation oil pressure in said each example as what acquires an abbreviation continuation target or mean values M1 and M2, it may change to this, for example, other means, such as preparing a variable aperture into a hydraulic circuit, may be used.
[0097]
[Effect of the Invention] By the above explanation, according to the good fluctuation valve gear of the internal combustion engine concerning this invention, so that clearly Since the good fluctuation valve gear was constituted from the 1st good fluctuation valve system which comes to connect a driving shaft and a cam shaft by the rockable annular disk, and the 2nd good fluctuation valve system to which the phase angle of a driving shaft and a crankshaft is changed, By controlling the hydraulic oil supplied to each good fluctuation valve system, the various valve timing according to an engine's operational status can be obtained easily.
[0098] Moreover, according to the configuration of claim 2, the valve timing according to an engine's operational status can be set up, by low loaded condition, fuel consumption can be improved and an output can be improved in the state of a heavy load. Furthermore, since what is necessary is just to operate only the 1st good fluctuation valve system which can adjust the both sides of an actuation angle and a closing motion stage to coincidence in shifting between a low load field and low rotation heavy load fields, it is stabilized and valve timing can be set up promptly.
[0099] Furthermore, according to the configuration of claim 3 - claim 6, the torque shock at the time of shift can be reduced.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] The configuration explanatory view showing the whole good fluctuation valve gear configuration of the internal combustion engine concerning the 1st example of this invention.
[Drawing 2] the part which shows the important section of the 1st good fluctuation valve system -- a fracture Fig.
[Drawing 3] The sectional view which met the A-A line in drawing 2 .
[Drawing 4] The top view showing the important section of the 1st good fluctuation valve gear.
[Drawing 5] The sectional view which met the B-B line in drawing 4 .
[Drawing 6] The sectional view which met the C-C line in drawing 4 .
[Drawing 7] The sectional view in alignment with D-D line in drawing 3 .
[Drawing 8] The sectional view showing the important section of the 2nd good fluctuation valve system.
[Drawing 9] The property Fig. showing the rotation phase contrast property and valve-lift property of a driving shaft and a cam shaft by comparison.
[Drawing 10] The explanatory view showing the map for switching control action according to

an engine's operational status.
[Drawing 11] The property Fig. showing the relation of the valve timing of an inlet valve and the valve timing of an exhaust valve according to an engine's operational status.
[Drawing 12] The explanatory view showing the change-over map of operation concerning the 2nd example of this invention.
[Drawing 13] The property Fig. showing the rotation phase contrast and the valve-lift property of the driving shaft and cam shaft concerning the 3rd example of this invention by comparison.
[Drawing 14] The property Fig. showing the valve timing of the exhaust valve by the conventional technique, and an inlet valve.
[Description of Notations]
1 -- 1st good fluctuation valve gear
2 -- Driving shaft
3 -- Cam shaft
4 -- Inlet valve
8 13 -- Flange
10 -- Annular disk
11 14 -- Engagement slot
17 18 -- Pin
28 -- Drive
42 -- Controller
43 -- 2nd good fluctuation valve system

[Translation done.]